DOCUMENT RESUME

ED 101 530 EC 071 319

AUTHOR Horner, R. Don; Keilitz, Ingo
TITLE Training of Toothbrushing Behaviors of Mentally Retarded Adolescents. Working Paper No. 305.
INSTITUTION Parsons State Hospital and Training Center, Kans.
PUB DATE Apr 74
NOTE 20p.

EDRS PRICE MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS Adolescents; Behavior Change; *Dental Health; Exceptional Child Research; Institutionalized (Persons); Mentally Handicapped; Reinforcement; *Task Analysis; *Trainable Mentally Handicapped; *Training Techniques
IDENTIFIERS *Project MORE

ABSTRACT

A comprehensive toothbrushing program including detailed task analysis and specific training procedures was developed and evaluated for eight institutionalized mentally retarded adolescents (mean IQ 43.1). The first group of four Ss received token plus social reinforcement while the second group received only social reinforcement. All eight Ss showed significant improvement in their toothbrushing behaviors when compared to baseline measures, and six Ss met the criterion of correct performance in two of three consecutive sessions. (Author/CI)

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PARSONS RESEARCH CENTER

Working Paper #305 April 1974

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R. Don Horner and Ingo Keilitz

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TRAINING OF TOOTHBRUSHING BEHAVIORS OF MENTALLY RETARDED ADOLESCENTS[1]

R. Don Horner and Ingo Keilitz

Bureau of Child Research, University of Kansas, and

Parsons State Hospital and Training Center, Parsons, Kansas

ABSTRACT

The need for self care by mentally retarded individuals in behaviors such as toothbrushing has resulted in an increasing number of published programs, guides, and manuals to meet that need. Shortcomings in published materials, however, have limited their utility. A comprehensive toothbrushing program was developed and evaluated which attempted to make up those shortcomings and included:

1) a detailed task analysis of toothbrushing,
2) training procedures specific to each component of the task analysis, and
3) specifications for data collection by the trainer.

Eight mentally retarded adolescents, in two groups, individually received acquisition training by a procedure including programmed opportunities for independent performances, verbal instruction, modeling, demonstration, and physical assistance. The first group of four subjects received token plus social reinforcement; the second received only social reinforcement. All eight subjects showed significant improvement in their toothbrushing behaviors when compared to baseline measures. Six of the eight subjects achieved a stringent performance criterion, i.e., correct performances of all toothbrushing steps, two out of three consecutive sessions. These results, together with a general feasibility of program application, suggest greater generality of effectiveness of the toothbrushing program for mentally retarded individuals.

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[1]This investigation was performed pursuant to Grant No. 0-71-0449(607) with the Bureau of Education for the Handicapped, Office of Education, U.S. Department of Health, Education, and Welfare. Points of view or opinions stated do not necessarily represent official Office of Education policy. Reprints may be obtained from R. Don Horner, Wessex Regional Hospital Board, Winchester SO 22 5DH, Hampshire, England, or Ingo Keilitz, Project MORE, Bureau of Child Research, P. O. Box 290, Parsons, Kansas 67357.

The necessity of training basic self-care behaviors to mentally retarded persons has made the establishment of such behaviors the objective for an increasing number of training efforts. One class of self-care behaviors which has received attention is toothbrushing. Recent reports have indicated that the need for dental hygiene among retarded individuals is greater than that among nonretarded individuals (Miller, 1965; Nickol, 1973). While various published reports, training programs, and teaching guides have focused on the training of toothbrushing behaviors, they seem to have one or more of the following limitations making implementation impractical or difficult:

1) inadequate task analysis or detailed task description;
2) unspecified or ambiguous information regarding teaching techniques;
3) insufficient information for measuring success of program application, i.e., inadequate data collection specification, and
4) inadequate evaluation of program effectiveness in an educational setting.

Very few studies dealing with toothbrushing behaviors have been reported in the research literature. Lattal (1969) reported the usefulness of a contingency management procedure in the control of previously established toothbrushing behaviors in eight boys at a summer camp for children. These behaviors occurred only infrequently during baseline conditions with and without specific instructions to the boys to brush their teeth. Unfortunately, no task analysis of the target behavior (brushing teeth) into behavioral components and performance sequence was reported. Thus, no information concerning the training of specific behavior components of toothbrushing is available.

More recently, Abramson and Wunderlich (1972) reported the results of a program used to train nine severely retarded boys to brush their teeth. The program was divided into three stages involving:

1) discrimination training to teach the boys to choose the proper toothbrush,
2) reinforcement of successive approximations of three behaviors involving the application of paste on brush and the removal and replacement of the toothpaste cap, and
3) transfer of the behaviors already established to a bathroom setting and a combination of verbal instructions, demonstration, physical assistance, and reinforcement of successive approximations for establishing 12 additional behaviors necessary for appropriate toothbrushing.

While the desired behavior, proper brushing of teeth, was divided into 20 components, the lack of operational definitions of ambiguous components, e.g., "efficient and quick brushing," minimizes the utility of the program and severely limits replicability. A comparison of pretraining and posttraining behaviors indicated improvements in all eight of the subjects who completed the program.

Outside of the research literature, at least two training programs for teachers and parents of retarded individuals have included extensive task analyses of toothbrushing, providing information about teaching techniques and also providing the user of the programs with some rationale and specific information for collecting data and measuring student success (Anderson, Hodson, Jones, Todd, Walters, & Gregersen, 1972; Baldwin, Fredericks, & Brodsky, 1973).

Baldwin *et al.* provided two task analyses of toothbrushing behavior. One divided toothbrushing into 29 components, including the use of a glass to rinse the mouth; the other involved rinsing the mouth by means of wetting the toothbrush and involved 26 specific behavioral components. The toothbrushing program reported by Anderson *et al.* was presented in four parts. First, the objective of the program was indicated, i.e., brushing teeth; an outline was presented including the behavior components of toothbrushing and a teaching strategy for each component; the type of consequences provided the student were indicated; and, finally, a procedure for evaluating training was outlined. Unfortunately, neither Baldwin *et al.* or Anderson *et al.* provide information as to the extent of student change attributable to actual program application.

In view of the pressing need to provide self-care training for mentally retarded persons and the increasing number of programs to meet those needs, adequate program evaluation seems to rank high as a priority objective in program development. The purpose of the present study was to apply a within-subject experimental design to evaluate the application of a comprehensive toothbrushing program[2] which included a detailed task analysis, and a systematic training strategy. While the program contained data collection procedures with provisions for session-by-session, as well as pretraining and posttraining measures, no attempt to evaluate the trainers' proficiency in using these procedures was made.

METHOD

Subjects

Two mentally retarded girls, Coleen and Joyce, and six retarded boys,

[2]A revised version of the program described here has been published commercially and referenced under Horner, R. D., Billionis, C. S., & Lent, J. R. *Toothbrushing Program.* (Rev. ed.) Seattle: Edmark Associates, 1974.

Tom, Michael, Larry, Russell, Charles, and Jessie, all residents of Parsons State Hospital and Training Center, Parsons, Kansas, served as subjects. The selection criterion was the available free time in the daily schedule of the residents of two residential cottages. The mean age, mean length of institutionalization, and mean IQ of the subjects were 13.0 years, 2.6 years, and 43.1. Charles and Michael were described as mildly retarded in their medical records; the remaining subjects were described as moderately retarded. Medical records of the eight subjects indicated, among other things, the following diagnostic references: congenital cerebral defects, unknown prenatal influences, secondary cranial anomaly, controlled convulsive disorder, Down's syndrome, language impairment, cerebral palsy, epilepsy, mild hydrocephalus, some spasticity of the limbs, and postnatal cerebral infection. All subjects were ambulatory and displayed no behavior problems which interfered with training.

Trainers

Trainers for the eight subjects were four nonretarded adults who had no prior teaching experience with either mentally retarded individuals or the training procedures described below. The trainers ranged in age from 19 to 24 years. One trainer was a female college graduate working as a VISTA volunteer assigned to a community action project. She trained Michael, Larry, and Russell and received remuneration for her training services. Tom was trained by a female junior college student who offered her time in order to complete a public service project. The two other trainers, both female, were available as part of a practicum experience associated with a psychiatric nursing course. One student nurse trained Charles and Jessie, the other trained Coleen and Joyce; neither received remuneration for their services.

Toothbrushing Behaviors

A detailed identification and description of the specific behavioral steps and performance sequence, i.e., task analysis (cf., Rensick, Wang, & Kaplan, 1973; Hannum, 1974; Mager, 1972), of toothbrushing was performed, yielding the response classification for toothbrushing behaviors presented in Table 1. This task analysis represented the objectives and sequence for training and the operational definition of correct responses for recording and reliability purposes. During baseline, responses were considered correct if they conformed to the description of the steps in Table 1, regardless of the sequence or order in which they occurred. During training, responses occurring out of sequence were recorded as incorrect.

TABLE 1

DESCRIPTION OF TOOTHBRUSHING STEPS

1. *Pick up and hold the toothbrush.* The student starts each session by first turning on the water and then picking up the toothbrush by its handle.

2. *Wet the toothbrush.* The student continues to hold the toothbrush, placing the bristles under the running water for at least five seconds. Then the student turns off the running water and lays the toothbrush down.

3. *Take the cap off the toothpaste tube.* The student places the tube of toothpaste in his least preferred hand, unscrews the cap with the thumb and index finger of his preferred hand, and sets the cap on the sink.

4. *Put the toothpaste on the brush.* The student picks up the toothbrush by its handle, holds the back part of the bristles against the opening of the toothpaste tube, squeezes the tube, moves the tube toward the front bristles as toothpaste flows out on top of the bristles, and lays the toothbrush on the sink with the bristles up.

5. *Put the cap back on the toothpaste tube.* The student picks up the toothpaste cap with the thumb and index finger of his preferred hand, screws the cap on the toothpaste tube which he

is holding in his least preferred hand, lays the tube of toothpaste down, and picks up the toothbrush by its handle with his preferred hand.

6. *Brush the outside surfaces of your teeth.* The student brushes the outside surfaces of his upper and lower teeth on both sides and in the center of his mouth, using either an up and down or back and forth motion, for at least thirty seconds.

7. *Brush the biting surfaces of your teeth.* The student brushes the biting surfaces of his upper and lower teeth on both sides and in the center of his mouth, using a back and forth motion, for at least thirty seconds.

8. *Brush the inside surfaces of your teeth.* The student brushes the inside surfaces of his upper and lower teeth on both sides and in the center of his mouth, using a back and forth motion, for at least thirty seconds.

9. *Fill the cup with water.* The student lays the toothbrush down, picks up a cup, places it under the faucet, turns on the water, fills the cup, and turns off the water.

10. *Rinse the toothpaste from your mouth.* The student spits out any excess toothpaste foam, takes a sip of water, holds it in his mouth, swishes it around in his mouth, and spits it out. If any toothpaste foam is still present in his mouth, this procedure should be repeated.

11. *Wipe your mouth.* The student pulls a tissue from the container (or picks up a hand towel) and dries his mouth.

12. *Rinse your toothbrush.* The student picks up his toothbrush by its handle, turns on the water, and places the bristles under the running water until the bristles are free of toothpaste (any toothpaste not removed by the water may be dislodged by drawing the fingers across the bristles), turns off the water, and lays the toothbrush down.

13. *Rinse the sink.* The student turns on the water and rubs his hand around the inside of the sink to wash any residue of toothpaste or toothpaste foam down the drain. He then turns off the water. If necessary, the student dries his hands on a tissue or hand towel.

14. *Put your equipment away.* The student puts the toothpaste and toothbrush in the proper storage place. (If a glass and hand towel are used, these should also be returned to the storage place.)

15. *Throw the paper cup and tissue away.* Any used paper cups and tissues should be placed in a wastebasket.

Procedures

The experimental design consisted of a multiple-baseline procedure across individuals (Baer, Wolf, & Risley, 1968; Kazdin, 1973) which included Tom, Michael, Larry, and Russell, and a systematic replication (Sidman, 1960) involving the four remaining subjects and their trainers. Training of the replication group differed from the original group only in the reinforcement procedure applied. The setting for training of the first group was a large experimental room containing a single sink and a mirror directly above the sink. Training of the replication group was conducted in the bathroom of the residential living unit of the subjects.

Baseline

The baseline procedure for all subjects involved the following: the trainer placed a toothbrush, tube of toothpaste, disposable cup, and a box of facial tissues near the sink at each session and provided the verbal statement: *Name, here is everything you need to brush your teeth. I want you to brush your teeth by yourself. Do the very best you can.* This procedure was repeated at the start of each baseline session. During baselines the trainers performed no additional procedures.

All baseline sessions, as well as subsequent training sessions, were scheduled once daily. The number of baseline sessions conducted in the first group was 1, 5, 10, and 15 for Tom, Michael, Larry, and Russell. The number of baseline sessions conducted in the replication group for Charles, Coleen, and Joyce was 1, 3, and 6. Jessie was scheduled for nine baseline sessions but training was initiated after only three baseline sessions due to an inadvertent error. Fewer baseline sessions were conducted for the replication group due to an observed increase in irrelevant and competing behaviors by Russell in the original group after the tenth baseline session.

Training

Trainers performed four types of procedures during training: 1) No Help, 2) Verbal Instruction, 3) Demonstration + Verbal Instruction, and 4) Physical Guidance + Verbal Instruction. These four procedures were applied successively to the training of each one of the toothbrushing steps (Table 1).

Training sessions were conducted daily and all the toothbrushing steps were trained in each session. A correct response, defined by the response classification in Table 1, was reinforced by the trainer, and training of the next step was initiated by providing the subject the opportunity to perform with No Help. As acquisition training progressed, the number of training procedures applied to each step decreased. In this way, training was gradually faded. The four subjects in the first group, Tom, Michael, Larry, and Russell, received tokens plus social reinforcement during training. A paper cup was placed within sight, but outside the reach, of the student and a token was dropped into the cup after each correct response. Tokens were exchanged for pieces of sugarless gum at a ratio of five to one at the end of each training session. Tokens were accompanied by social praise and pats on the back. The four students in the systematic replication group, Charles, Jessie, Coleen, and Joyce, received only social reinforcement throughout training.

As in baseline, all sessions began with the introductory statement by the trainer, prompting the student to initiate toothbrushing. Toothbrushing steps were trained according to the description and sequence outlined in Table 1. For each step, the trainer provided No Help for approximately five seconds, giving the subject an opportunity to perform the step without assistance.

If the student failed to make an observable response after five seconds, a nonspecific verbal prompt, e.g., *Go ahead* or *What's next?*, was provided. If the student made an inappropriate response, e.g., "making faces" in the mirror or licking the toothpaste tube, or attempted another toothbrushing step, Verbal Instruction for that step was provided immediately by the trainer. Verbal Instruction for each step consisted of a short imperative statement describing the desired behavior, e.g., *Wet the toothbrush.* If the subject responded correctly, reinforcement was provided and training of the next step was initiated with No Help. If the student failed to make an observable response in approximately five seconds, Verbal Instruction was repeated.

If the student made an inappropriate response, e.g., sucked on the faucet or blew bubbles into the cup of rinse water, attempted another toothbrushing step, or made no observable response approximately five seconds after the repetition of Verbal Instruction, the next training procedure, Demonstration + Verbal Instruction, was initiated with that step. Demonstration + Verbal Instruction included verbal instruction in addition to a simultaneous demonstration of the desired behavior. The demonstration consisted of pointing or directing the subject's responses, as well as modeling of the desired behavior. For example, while a trainer was instructing the subject to *Put the cap back on the toothpaste tube*, she might point to the cap and then to the toothpaste tube, followed by moving her hand in a circular motion as if screwing the cap on the tube. If the student performed the step correctly within five seconds after a Demonstration + Verbal Instruction, reinforcement was provided and training of the next step was initiated with No Help. No observable response within that time limit resulted in a repetition of Demonstration + Verbal Instruction.

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Failure to respond to the repetition or the occurrence of inappropriate behaviors resulted in the application of the last, or fourth, training procedure, Physical Guidance + Verbal Instruction, to that step. The training method for this procedure consisted of the trainer instructing, as well as holding, guiding, or otherwise physically assisting the subject in initiating the desired behavior, but allowing the subject to complete it on his own. Correct completions of the step were reinforced followed by the training of the next step with No Help. Failures to complete the step correctly resulted in the repetition of Physical Guidance + Verbal Instruction. If an error in performance or a failure to complete the step occurred after the repetition of Physical Guidance + Verbal Instruction, training of that step ceased and the training of the next step was initiated with No Help.

Recording and Observer Agreement

Correct responses following No Help, Verbal Instruction, Demonstration + Verbal Instruction, and Physical Guidance + Verbal Instruction were recorded during each session by one or two observers. When two observers were present, they simultaneously but independently scored the responses. Correct responses were defined by the response classification of the toothbrushing steps in Table 1. Percent of observer agreement was calculated by dividing the number of agreements and disagreements in recording the responses following the No Help procedure only. Mean percent agreements based upon 20 of the 30 baseline sessions and 45 of the total 72 training sessions conducted with Michael, Larry, and Russell were 59 percent, 97 percent, and 96 percent for baseline sessions and 95 percent, 98 percent, and 97 percent for training sessions. Agreement data was collected only once during training for Tom and once during baseline for Charles, Jessie, Coleen, and Joyce. Mean percent observer

agreement computed for this data was 92 percent for baseline and 94 percent for training.

RESULTS

Figure 1 shows the number of toothbrushing steps performed by Tom, Michael, Larry, and Russell during baseline and those steps performed correctly with No Help during training. Data points indicate only performances of the toothbrushing steps which the subject performed correctly and required no training intervention, i.e., No Help, by the trainer. An arbitrary training criterion, all steps performed correctly two out of three consecutive sessions, was reached by Michael in 30 sessions, by Larry in 24, and by Russell in 18. Tom's performance stabilized after 20 sessions; his best performance did not exceed 13 correct steps, a level achieved during six separate sessions. Tom was consistently unable to perform Step 6 and Step 10 with No Help from the trainer. In the last six training sessions, Step 6, *Brush the outside surfaces of your teeth*, required Physical Guidance + Verbal Instruction once, Demonstration + Verbal Instruction twice, and Verbal Instruction three times in order to elicit a correct performance. Step 10, *Rinse the toothpaste from your mouth*, was performed incorrectly by Tom following even the most intensive training procedure, Physical Guidance + Verbal Instruction, in the last six sessions. Tom's training was discontinued after 36 sessions because the trainer's commitment to the program terminated.

The pattern of the types and number of training procedures required for acquisition of the toothbrushing steps was similar for Michael, Larry, and Russell. More intensive training was required in the initial training sessions. As training continued, fewer and less intensive training procedures were required for correct performance. For example, on the first day of

Figure 1

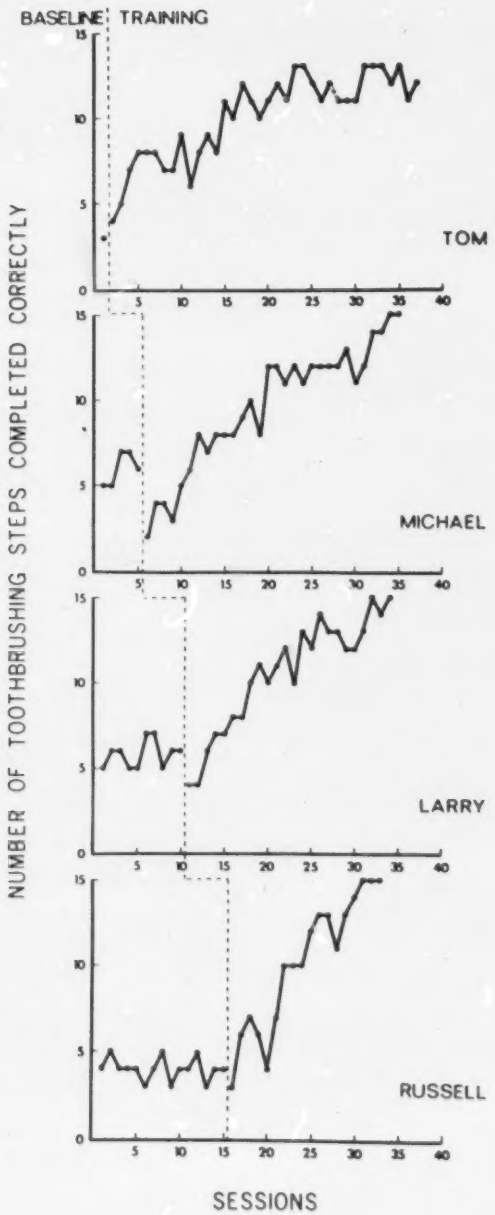

Figure 1. The number of toothbrushing steps performed correctly by the four subjects in the first group. The broken line through the individual graphs indicates the termination of baseline and the beginning of training for each of the subjects.

training, the three subjects mastered the 15 toothbrushing steps as follows:

Number of steps performed correctly with:	Michael	Larry	Russell
No Help	2	4	3
Verbal Instruction	8	3	4
Demonstration + Verbal Instruction	2	4	3
Physical Assistance + Verbal Instruction	3	4	5

By the tenth training session the number of steps mastered by the three subjects clearly indicated improvement:

Number of steps performed correctly with:	Michael	Larry	Russell
No Help	8	10	12
Verbal Instruction	4	2	1
Demonstration + Verbal Instruction	0	1	1
Physical Assistance + Verbal Instruction	3	2	1

Figure 2 presents acquisition performance with No Help for the four subjects in the replication group. Baseline performance was higher for Charles, Jessie, Coleen, and Joyce than the initial group; the mean number of steps performed correctly averaged across subjects and baseline sessions was 7.7 for the replication group while it was only 4.7 for the initial group of four subjects. Criterion performance, i.e., two of three consecutive sessions of correct performance of all the steps, was achieved in 20 sessions by Charles and Joyce, and by Coleen in 21 training sessions. Jessie had not reached criterion performance after 25 training sessions when training was terminated due to the departure of his trainer. While Jessie was unable to master all the steps with No Help, only Verbal Instruction was necessary during the final training session to produce correct performance of the two steps not mastered with No Help. A similar minimal training intervention was necessitated in the last few training sessions for Charles, Coleen, and Joyce. In the last five training sessions for these three subjects, Verbal Instruction was sufficient to produce correct performance for all but one step for Coleen in session 20.

Figure 2

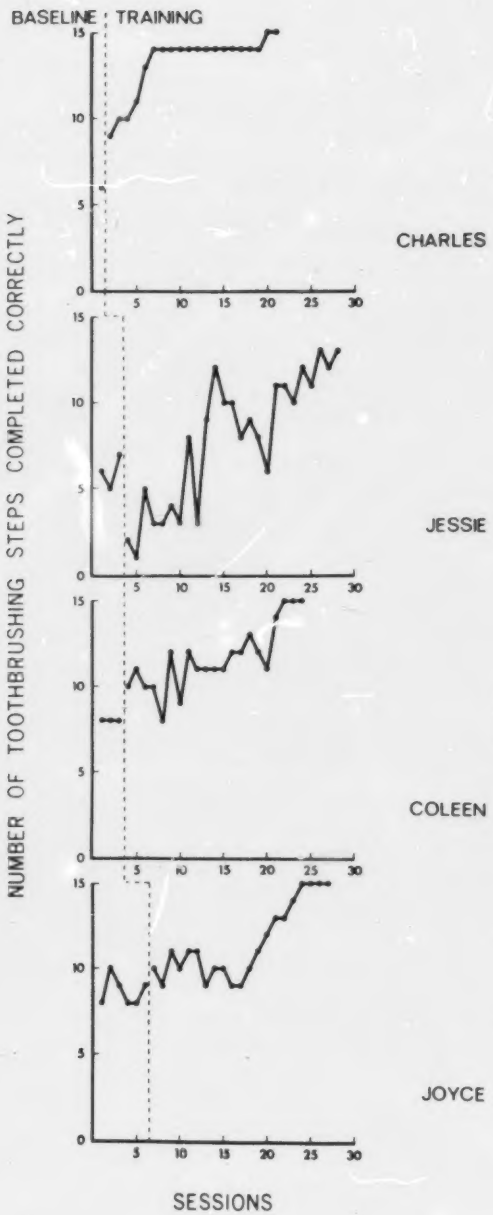

Figure 2. The number of toothbrushing steps performed correctly by the four subjects in the replication group. The broken line through the individual graphs indicates the termination of baseline and the beginning of training for each of the subjects.

DISCUSSION

The toothbrushing program produced a high performance level in the first group of subjects, as well as in the systematic replication group which received social reinforcement only. Six of the eight subjects in the two groups achieved a high criterion performance standard in 18 to 30 training sessions. The remaining two subjects, Tom and Jessie, made significant gains over their baseline performance. While not reaching the stringent performance requirements set in this study, the standard of toothbrushing behaviors acquired by Tom and Jessie would more than likely be indistinguishable from that of their noninstitutionalized normal peers. These results cannot be attributed simply to practice or the passage of time since the multiple baseline procedure effectively demonstrated that the subjects' performances did not change until the training was initiated.

Comparisons of the present program with previously described acquisition training programs are limited by the fact that only the study by Abramson and Wunderlich (1972) reported acquisition of specific toothbrushing behaviors. The study was also conducted with a younger group of subjects than those of the present study. The lack of operational definitions of behaviors and a failure to report interobserver agreement data make comparison difficult, if not impossible. Further, these authors did not report sufficient information as to the crucial third stage of their acquisition training program where the actual brushing of the teeth occurred. It was reported, however, that the nine subjects in the study were observed "to brush the left, middle, and right mouth area" an average of 81 percent of the time after training; the subjects also "regulated the water faucet and rinsed their mouth after brushing" more frequently after training. The eight subjects who completed the Abramson and

Wunderlich program acquired a mean of 84 percent of the behaviors as revealed by posttraining checks. The eight subjects in the present study acquired a mean of 95 percent of the toothbrushing behaviors on the final day of training. Notwithstanding the speculative nature of such comparisons, the acquisition data of the present study seems to compare favorably with the data reported in the Abramson and Wunderlich study.

The performances during the first few training sessions for Michael, Larry, and Russell in the first group and Jessie in the replication group indicate a problem with the training of skill components in a predetermined sequence. The number of steps completed correctly by these subjects during the initial training sessions was less than during baseline. This drop was largely due to the fact that during baseline these subjects performed such steps correctly but not in the sequence prescribed in training. Such responses, while considered correct during baseline, were treated as inappropriate responses during training.

The advantage of training toothbrushing using the same predetermined sequence of steps for all subjects is that the trainer is not required to determine the sequence of steps individually for each subject. From a practical standpoint, this is an important consideration since trainers of retarded individuals are often severely limited in the amount of time available to them for training. It is also parsimonious to communicate a written program with a set sequence of task components instead of various sequence options. Nonetheless, whether these advantages outweigh the disadvantages of undoing any sequence of correct responses established during baseline is subject to question. One might speculate that Michael, Larry, and Russell might have achieved the performance criterion several sessions earlier had it not been for the training requirement of a set sequence of correct

responses different from the performance sequence in baseline. Although this was not done in the present study, the sequence in which the 15 steps of the program were trained could have been determined from the baseline performance of each subject. In a task such as toothbrushing, the sequence of components in a task analysis are largely determined by the task. Applying the toothpaste to the brush as one component, for example, must appear after the removal of the toothpaste cap. Sequence is also partially determined by the function of the component, e.g., rinsing the sink should appear after the brushing behaviors. With those restrictions of the task and the function of the component, the sequence of the components can be established by the subject and maintained throughout training.

In summary, the results of the present study constitute the kind of evaluation information about the present program which is generally unavailable for other published programs or guides for the training of toothbrushing. With an increase in such programs for self-care training of mentally retarded individuals, the need for evaluative information becomes paramount. Further, the written program given to the trainers provided a detailed task analysis, a clearly specified training technique for each component of the task, and a data collection procedure. The four-stage training procedure applied to the teaching of all the steps of the program was easily implemented by the trainers in this study, suggesting its feasibility in other educational settings. These aspects, together with the fact that trainers with little experience in teaching retarded individuals effectively implemented the program, seem to suggest considerable utility and generality of the present toothbrushing program.

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